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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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09/704,539

11/03/2000

Ken Kitamura

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4655

7590

12/10/2004

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EXAMINER

KAO, CHIH CHENG G

ART UNIT

PAPER NUMBER

2882

DATE MAILED: 12/10/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

## Office Action Summary

**Application No.**

09/704,539

**Applicant(s)**

KITAMURA ET AL.

**Examiner**

Chih-Cheng Glen Kao

**Art Unit**

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 27 September 2004.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 4-23,25,26 and 28-49 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 5-7,16-18,20-23,25,26,29,30,33 and 35-48 is/are allowed.
- 6) ☒ Claim(s) 4,8-15,19,28,31,32,34 and 49 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 10 November 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some \* c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- |  |   |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892)   | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                                   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____  |

## DETAILED ACTION

### *Claim Rejections - 35 USC § 103*

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

1. Claims 4, 10, 13-15, 19, 28, 31, 32, 34, and 49 are rejected under 35 U.S.C. 103(a) as being unpatentable over Takasaki et al. (US Patent 4980736) in view of Kozuka et al. (Translation of JP 09-102627) and Deane et al. (US Patent 6064091).
2. Regarding claims 4 and 15, Takasaki et al. discloses a photoelectric conversion device (Figs. 1A) comprising or consisting of a single carrier generation/multiplication layer (Fig. 1B, #114) composed of amorphous silicon (col. 5, lines 44-56), an electron injection inhibiting layer composed of amorphous silicon carbide of p-type conductivity (Fig. 1B, #115, and col. 6, lines 56-60), a hole injection inhibiting layer composed of amorphous silicon nitride of n-type conductivity (Fig. 1B, #113, and col. 6, lines 47-51), wherein the carrier generation and multiplication layer is between the electron and hole injection inhibiting layers (Fig. 1B), and wherein the composition ratio C/Si of the electron injection inhibiting layer is adjusted appropriately to 1.5 or lower (col. 6, lines 65-69).

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However, Takasaki et al. does not specifically disclose the combination of silicon nitride and silicon carbide.

Kozuka et al. teaches the combination of silicon nitride and silicon carbide (Drawing 5, #302 and 307).

It would have been obvious, to one having ordinary skill in the art at the time the invention was made, to incorporate the device of Takasaki et al. with the combination of silicon carbide and silicon nitride of Kozuka et al., since one would be motivated to make such a modification to create a larger multiplication factor of the signal (Paragraph 0050) as shown by Kozuka et al. Also note that it would have been within the general skill of a worker in the art to select a known material on the basis of its suitability for carrier blocking as a matter of design choice (col. 6, lines 47-64) as implied from Takasaki et al.

3. Regarding claim 10, Takasaki et al. as modified above suggests a device as recited above.

However, Takasaki et al. does not disclose a monocrystalline silicon substrate.

Kozuka et al. further teaches a monocrystalline silicon substrate (Paragraph 0063).

It would have been obvious, to one having ordinary skill in the art at the time the invention was made, to further incorporate the device of Takasaki et al. as modified above with the monocrystalline silicon substrate of Kozuka et al., since one would be motivated to make such a modification to provide better support (Drawing 11, #601) as implied from Kozuka et al.

4. Regarding claims 13, 14, and 19 and for purposes of being concise, Takasaki et al. as modified above suggests a device as recited above.

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However, Takasaki et al. does not specifically disclose a plurality of photoelectric conversion units, an electric field reducing layer between the multiplication layer and the carrier injection inhibiting layer, a plurality of accumulation units, and an output unit.

Kozuka et al. teaches a plurality of photoelectric conversion units (Drawing 14, #742), an electric field reducing layer between the multiplication layer and the carrier injection inhibiting layer (Abstract, problem to be solved), a plurality of accumulation units (Drawing 14, #741), and an output unit (Drawing 14, #750).

It would have been obvious, to one having ordinary skill in the art at the time the invention was made, to further incorporate the device of Takasaki et al. as modified above with the photoelectric conversion, accumulation, and output units of Kozuka et al., since one would be motivated to make such a modification to convert a larger image with more pixels (Drawing 14) as implied from Kozuka et al.

It would have been obvious, to one having ordinary skill in the art at the time the invention was made, to further incorporate the device of Takasaki et al. as modified above with the electric field reducing layer of Kozuka et al., since one would be motivated to make such a modification to further reduce dark current caused by interfacial defects (Abstract, problem to be solved) as shown by Kozuka et al.

5. Regarding claims 28, 31, 32, and 34, Takasaki et al. further discloses amorphous silicon nitride of n-type conductivity as hydrogenated (col. 6, lines 47-51).

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6. Regarding claim 49 and for purposes of being concise, Takasaki et al. as modified above suggests a device as recited above.

However, Takasaki et al. does not specifically disclose discontinuity of an energy level at an interface between an amorphous silicon nitride layer and an amorphous silicon layer on a valence band side larger than on a conduction side.

Kozuka et al. teaches discontinuity of an energy level at an interface between an amorphous silicon nitride layer and an amorphous silicon layer on a valence band side larger than on a conduction side (Drawing 6, energy levels from #307 to 205).

It would have been obvious, to one having ordinary skill in the art at the time the invention was made, to further incorporate the device of Takasaki et al. as modified above with the conduction and valence band energy levels of Kozuka et al., since one would be motivated to make such a modification to propagate a greater avalanche (Drawing 6) as implied from Kozuka et al. for a stronger output signal.

7. Claims 8 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Takasaki et al. in view of Kozuka et al. as applied to claim 4 above, and further in view of Norström (US Patent 6077752).

Takasaki et al. as modified above suggests a device as recited above.

However, Takasaki et al. does not disclose a polycrystalline or microcrystalline silicon substrate.

Norström teaches the equivalency of polycrystalline, microcrystalline, and monocrystalline silicon substrates (col. 3, lines 10-12).

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It would have been obvious, to one having ordinary skill in the art at the time the invention was made, to incorporate the device of Takasaki et al. as modified above with the polycrystalline, microcrystalline, or monocrystalline silicon substrates of Norström, which is explained with motivation as follows. Since these silicon substrates were art-recognized equivalents at the time the invention was made, one of ordinary skill in the art would have found it obvious to substitute one type of silicon substrate for another. One would be motivated to incorporate any one of these substrates to provide better support for the device.

8. Claim 11 is rejected under 35 U.S.C. 103(a) as being unpatentable over Takasaki et al. in view of Kozuka et al. as applied to claim 4 above, and further in view of Nakayama et al. (US Patent 6157072).

Takasaki et al. as modified above suggests a device as recited above.

However, Takasaki et al. does not disclose a metal substrate.

Nakayama et al. teaches a metal substrate (col. 20, lines 48-55).

It would have been obvious, to one having ordinary skill in the art at the time the invention was made, to incorporate the device of Takasaki et al. as modified above with the metal substrate of Nakayama et al. since one would be motivated to make such a modification to provide a more convenient board to place photoelectric conversion devices on (col. 20, lines 48-55) as implied from Nakayama et al.

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9. Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Takasaki et al. in view of Kozuka et al. as applied to claim 4, and further in view of Fukuda et al. (US Patent 5635327).

Takasaki et al. as modified above suggests a device as recited above.

However, Takasaki et al. does not disclose boron in the carrier generation layer.

Fukuda et al. teaches boron in the carrier generation layer (col. 4, lines 48-57).

It would have been obvious, to one having ordinary skill in the art at the time the invention was made, to incorporate the device of Takasaki et al. as modified above with the boron of Fukuda et al., since one would be motivated to make such a modification to better control dark resistance (col. 4, lines 48-57) as shown by Fukuda et al., which is related to the dark current.

***Allowable Subject Matter***

10. Claims 5-7, 16-18, 20-23, 25, 26, 29, 30, 33, and 35-48 contain allowable subject matter.

11. The following is a statement of reasons for the indication of allowable subject matter.

Regarding claims 6, 7, and 21, prior art does not disclose or fairly suggest a photoelectric conversion device including an energy level at an interface between an amorphous silicon nitride layer and an amorphous silicon layer discontinued on a valence band side and equal on a conduction band side, in combination with all the limitations in the claim. Claims 5, 23, 29, 30, 35, and 39-48 contain allowable subject matter by virtue of their dependency.



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Regarding claim 16, prior art does not disclose or fairly suggest a solid-state imaging device including an energy level at an interface between an amorphous silicon carbide layer and an amorphous silicon layer discontinued on a conduction band side and equal on a valence band side, in combination with all the limitations in the claim. Claims 20 and 33 contain allowable subject matter by virtue of their dependency.

Regarding claims 22, 25, and 26, prior art does not disclose or fairly suggest a solid-state imaging device including an energy level interface between an amorphous silicon nitride layer and an amorphous silicon layer discontinued on a valence band side and equal on a conduction band side, in combination with all the limitations in the claim. Claims 17, 18, and 36-38 contain allowable subject matter by virtue of their dependency.

### ***Response to Arguments***

12. Claim objections and rejections under USC 112, 1<sup>st</sup> paragraph, in the Office Action mailed 3/25/04 have been withdrawn in light of the Amendment filed 9/27/04.

13. Applicant's arguments with respect to claims 4, 8-15, 19, 28, 31, 32, 34, and 49 have been considered but are moot in view of the new ground(s) of rejection.

14. Applicant's arguments filed 9/27/04 have been fully considered but they are not persuasive.

Regarding the combination of Takasaki et al. and Kozuka et al. and in response to Applicant's argument that the Examiner's conclusion of obviousness is based upon improper

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hindsight reasoning, it must be recognized that any judgment on obviousness is in a sense necessarily a reconstruction based upon hindsight reasoning. But so long as it takes into account only knowledge which was within the level of ordinary skill at the time the claimed invention was made, and does not include knowledge gleaned only from the applicant's disclosure, such a reconstruction is proper.

Applicant argues that the detector of Kozuka et al. is different in technology by explicitly focusing on the separate carrier generation and multiplication layers of Kozuka et al. versus the single layer of the claimed invention. Although, the Examiner agrees that these detectors are different in that particular aspect, the detectors are still fundamentally the same, since they are both avalanche multiplication detectors with electron and hole inhibiting layers surrounding the carrier generation/multiplication layer. It would have been obvious to incorporate elements of one with the other.

Applicant further argues that the Examiner has not established motivation for the proposed combination. The Examiner disagrees. As noted above, motivation has been explicitly established with the phrase "one would be motivated to make such a modification to...". Accordingly, Applicant's arguments are not persuasive, and the prior art still applies.

### ***Conclusion***

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

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A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

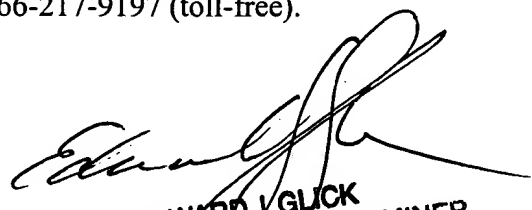
Any inquiry concerning this communication or earlier communications from the examiner should be directed to Chih-Cheng Glen Kao whose telephone number is (571) 272-2492. The examiner can normally be reached on M - F (9 am to 5 pm).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Ed Glick can be reached on (571) 272-2490. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



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